Working papers series

WP ECON 08.01

A Demand-Supply Analysis of the Spanish Education Wage Premium in the 1980s and 1990s

Manuel A. Hidalgo (U. Pablo de Olavide)

JEL Classification numbers: J24, J31, O33

Keywords: wage premium, relative demand, relative supply.

Universidad Pablo de Olavide Sevilla

Department of Economics

A Demand-Supply Analysis of the Spanish Education Wage Premium in the 1980s and 1990s

Manuel A. Hidalgo*

8th January 2008

Abstract

We estimate the demand for education in Spain, and use the estimated demand curve to analyze whether the evolution of the education wage premium in the 1980s and 1990s can be explained by a demand-supply framework. We find that growth in the demand for education in the 1980s was very similar to growth in the 1990s. Our empirical results show that difference in the evolution of the education wage premium between the two decades can be explained by combining observed changes in labor supply with steady labor demand growth.

JEL codes: J24, J31, O33

1 Introduction

Recent decades have seen substantial heterogeneity in the evolution of the education wage premium, both across countries and over time

*U. Pablo de Olavide. I am grateful to seminar participants of the VI Workshop on International Economics organized at the University of Malaga (Department of Theory and Economic History) and also to seminar participants at the University of Pablo de Olavide (Department of Economics) for very useful comments. I especially thank Antonio Ciccone, José Ignacio García and Jesus Rodriguez for very useful suggestions. I gratefully acknowledge support of project ECOD 1.07/085 (Ensayos sobre Andalucía y Nueva Economía) and the SEJ2006-04803/ECON (Efectos de las políticas fiscales y sociolaborales sobre el crecimiento). Ctra de Utrera, s/n, 41013, Seville, Spain. Email: mhidper@upo.es.

(Katz, Loveman, and Blanchflower 1995, Gottschalk and Smeeding 1997, Gottschalk and Joyce 1998, Acemoglu 2003). A natural starting point for the analysis of these differences is the demand-supply framework (D&S). The purpose of the D&S framework is to examine whether the evolution of the education wage premium can be approximated by supply-driven movements along a labor demand curve with a stable slope, including shifts in labor demand. The results have been quite encouraging in a variety of contexts. Katz and Murphy (1992), for example, conclude that the education wage premium in the U.S. between 1963 and 1987 can be explained by steady, secular shifts in the demand for educated workers combined with observed changes in relative supply. Katz, Loveman, and Blanchflower (1995) show that the D&S framework is also useful for understanding the evolution of the wage premium in four OECD countries (the U.S., U.K., Japan, and France). Card, Kramarz, and Lemieux (1999) incorporate wage-setting institutions in a D&S framework and show that this helps to explain relative wage trends among less-skilled workers in the U.S., Canada, and France in the 1980s. Acemoglu (2003) finds that the D&S with steady, secular shifts in the demand for educated workers can account for the differences in the evolution of wage inequality between Finland and Norway.

While the Spanish education wage premium has been studied quite intensively,[1] the literature on this subject has not yet explored how it may fit within the D&S framework. The goal of this study is to ascertain whether the D&S framework can help explain the evolution of the education wage premium in Spain during the two decades between 1980 and 2000. Our main finding is that the evolution of the premium during those two decades can be well approximated by combining the observed changes in labor supply with steady growth in the demand for education over the 1980-200 period. Interestingly, our estimates of the slope of the Spanish demand curve for education, and education demand growth, are quite similar to U.S. estimates.

One of the key elements of the D&S framework is the slope of the demand curve for education (which, in the standard D&S framework, is the inverse of the elasticity of substitution between more and less edu-

[1] See Abadíe (1997), Arellano, Bentolila, and Bover (2001), Torres (2002) and Martinez-Ros (2001) for example.

cated workers). The main difficulty faced when estimating this slope is that education supply and the education wage premium are determined simultaneously by demand and supply. Estimation therefore requires solving the standard identification problem (see Hamermesh, 1993, for a summary of this problem in the context of labor demand estimation). The empirical literature on the demand curve for education stretches back to the 1970s. Johnson (1970) estimates the elasticity of substitution between more and less educated workers to be 1.34 for a cross section of U.S. states in 1960. Ciccone and Peri (2005), using a panel of US states for the 1950-1990 period, and employing Acemoglu and Angrist's (2001) state-time-dependent child labor and compulsory school attendance laws as instruments for changes in the supply of education, find an elasticity of substitution of about 1.5. Angrist (1995) finds an elasticity of substitution of about 2 for data on Palestinian workers in the West Bank and the Gaza Strip during the 1980s; he uses the number of local higher-education institutions as an instrument for education supply. Fallon and Layard (1975), using cross-country data and employing income per capita as their instrument for education supply, obtain an estimate of 1.49 for the elasticity of substitution between more and less educated workers. Caselli and Coleman (2000) apply a D&S framework with endogenous technology to cross-country data to obtain an elasticity of substitution of 1.31. Katz and Murphy (1992) derive from U.S. time-series data for the 1963-1987 period an elasticity of substitution of about 1.4.

Because the national time-series data for Spain is insufficient to allow a valid estimate of the elasticity of substitution, we use the approach developed by Katz and Murphy to estimate the elasticity of substitution in a panel of Spanish regions, employing the beginning-of-period population structure as our instrument for education supply. The resulting estimate of the elasticity of substitution between more and less educated workers in Spain is close to the estimates reported by Katz and Murphy and Ciccone and Peri for the United States.

Our estimate of the slope of the Spanish demand curve for education for the 1980-2000 period allows us to examine the degree to which the D&S framework can be used to explain the evolution of the Spanish education wage premium during that period. Our chief empirical finding is that the evolution of the education wage premium as predicted by the framework fits quite closely with its actual evolution. For example, our estimates show a 0.6% decrease in the relative wage of more educated workers during the 1980s and a 1.1% increase during the 1990s, figures which come close to the actual 0.7% decrease in relative wages during the 1980s and 1.4% increase during the 1990s. Interestingly, we find similar annual growth rates for education demand in Spain during the 1980s and the 1990s (2.7% and 3.1%, respectively). These estimates come close to estimates for the United States: for example, Katz and Murphy (1992) estimate the relative U.S. demand shifts to be about 3.3% per year, while Acemoglu (2002) reports an increase of about 2.5% annually.

One explanation for cross-country differences in the evolution of wage inequality, especially in Europe, is that wage-setting institutions differ by country (Acemoglu, **?**, Card, Kramarz, and Lemieux, 1999, Abraham and Houseman, 1993...). Arguably, the most relevant institution for the Spanish case is collective wage bargaining; however, taking this into account does not affect our conclusion that the D&S framework is able to capture the evolution of the Spanish education wage premium.

The rest of the paper is structured as follow. Section 2 explains the data used; Section **??** explains the measurement of relative wages and education supply; Section 4 presents the estimation and decomposition results; Section **??** evaluates the possible effects of collective bargaining on relative demand estimates;and Section 6 concludes.

2 The Demand and Supply Framework

According to the demand and supply framework, the wage of more relative to less educated workers (the education wage premium) is determined by education demand and supply. The simplest model of relative demand is based on the constant elasticity of substitution (CES) firm-level production function (see, for example, Katz and Murphy, 1992). The model assumes that firms f have access to the following production function:

$$Y = [A_f L^\rho + B_f H^\rho]^{\frac{1}{\rho}} \tag{1}$$

where Y is output, H is the input of more educated (skilled) workers, and L the input of less educated (unskilled) workers. A_f and B_f denote the levels of factor-augmenting technology to which firms have access. It is straightforward to show that the production function parameter ρ determines the elasticity of substitution between factors σ. In particular, $\sigma = 1/(1-\rho)$, which implies that $\rho \leq 1$ is necessary for the isoquants to be convex and the education demand curve to be well-defined ($\rho = 1$ corresponds to the case where the two types of labor are perfect substitutes, while $\rho \to -\infty$ implies that there is no substitutability at all between more and less educated workers).

Firms are assumed to take wages in the labor market as given when making their hiring decisions. Firms' demand for education, the demand for more relative to less educated workers H/L, can be obtained from their first-order conditions for profit-maximization as

$$\left(\frac{H}{L}\right)_D = \left(\frac{B_f}{A_f}\right)^{\sigma}\left(\frac{w^H}{w^L}\right)^{-\sigma},$$

where we have used that $\sigma = 1/(1-\rho)$.

The D&S framework can be applied to the regional level by assuming that firms in region i have levels of factor-augmenting technology $A_f = A_i$ and $B_f = B_i$. A region's equilibrium education wage premium can now be determined by equating education demand with education supply $(H/L)_{Si}$in region i and solving for the relative wage for educated workers,

$$\left(\frac{w^H}{w^L}\right)_i = \left(\frac{B}{A}\right)_i\left(\frac{H}{L}\right)_{Si}^{-\frac{1}{\sigma}}.$$

Taking logs on both sides yields

$$\omega_i = b_i - \frac{1}{\sigma}h_{Si}; \tag{2}$$

where $\omega_i = Ln(w^H/w^L)$, $b = Ln(B/A)$ and $h = Ln(H/L)$. Taking differences over time (denoted by Δ) yields

$$\Delta\omega_{it} = \Delta b_{it} - \frac{1}{\sigma}\Delta h_{iSt}. \tag{3}$$

Hence, log changes in the education wage premium, $\Delta\omega_{it}$, are equal to shifts in education demand, Δb_{it}, plus supply-driven movements along the education demand curve, $-\frac{1}{\sigma}\Delta h_{iSt}$. The strength of the effect of supply changes on the wage premium depends the slope of the inverse education demand curve, $1/\sigma$, which is equal to the inverse of the elasticity of substitution between more and less educated workers. When the elasticity of substitution is high, supply changes will have small effects on the education wage premium (the inverse demand curve is flat). As the elasticity of substitution between more and less educated workers falls, the senstitivity of the education wage premium to changes in education supply increases. Figure 1 provides a graphic illustration of the relative wage effects of demand shifts and supply-driven movements along the demand curve. An increase in the relative supply, from h to h', moves the equilibrium point along the downward-sloping inverse demand curve (A to B) and reduces the education wage premium. An increase in the relative demand for educated workers moves the equilibrium point to C and increases the education wage premium. When there are demand and supply shifts, the equilibrium rests at point D; in this case the behavior of the education wage premium depends on which shift prevails.

The key feature of (3) from our point of view is that, once the elasticity of substitution between more and less educated workers has been estimated, it can be used to determine how supply and demand affect the evolution of the education wage premium. In order to resolve the standard simultaneous-equation identification problem, estimating the elasticity of substitution requires a valid instrument for shifts in the regional education supply.

3 Data and Measurement

3.1 Data

Individual Data

The wage data for this study comes from the Household Budget Survey (EPF) and Continuous Household Budget Survey (ECPF), [2] both of which cover a wide range of individual characteristics, such as education, age, region, annual earnings, type of employment contract,

[2]Dating from 1985, but with a change in methodology in 1997 and processed by the Spanish National Institute of Statistics (INE)

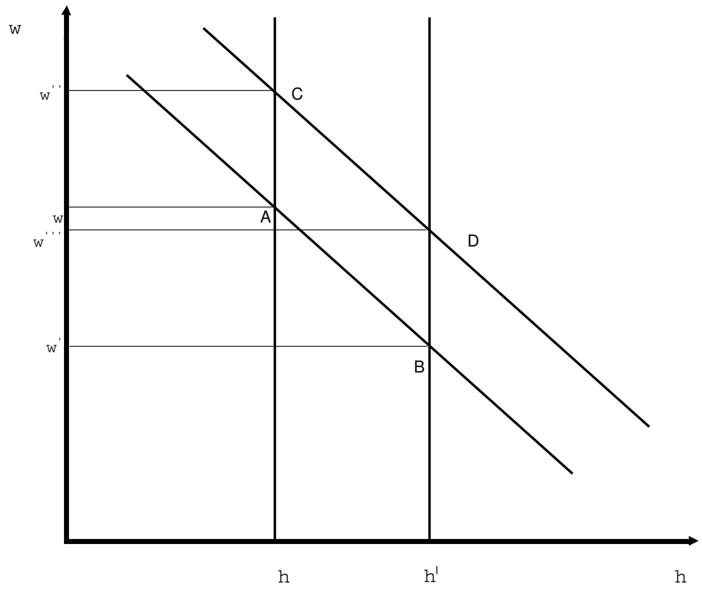

Figure 1: The Relative Demand for Education.

etc. The EPF is available for 1974, 1980-81 and 1990-1991; the ECPF is available for every quarter since 1985. Although there are some differences, the information in the EPF since 1980 is quite similar to that in the ECPF. As the focus here is on long-term trends, we will use data corresponding to 1980-1981, 1990-1991 and 2000-2001. The 1974 survey is not considered because it provides no usable education data. Other sources of wage data either lack needed individual data only or cover only short periods. An additional advantage of the EPF is that the methodology used to compile this data has remained relatively stable since 1980.

We will focus on heads of households aged 20 to 65 who work full time and are not self-employed. [3] Our schooling data refers to the highest of four possible degrees attained upon the subject's completion of primary school, lower secondary school, upper secondary school, or

[3] In 1990-91 and 2000-01 some characteristics are included for the head of family only.

university. We use this information to impute years of schooling to each of the individuals in our sample.[4]

Aggregate Supply Data

Our data on the supply of schooling comes from Instituto Valenciano de Investigaciones Económicas (IVIE) (Mas, Pérez, Uriel, Serrano, and Soler, 2002). The schooling data refers to workers in 17 (of 19) Spanish regions from 1964 to 2001. The categories are:

1. No schooling or primary schooling only (less than eight years of schooling)

2. Lower level secondary schooling (between eight and twelve years of schooling)

3. Upper secondary education (thirteen years of schooling)

4. College degree (sixteen to eighteen years of schooling)

Less educated workers are defined as belonging to either the first or the second group. That is, workers with fewer than 12 years of schooling are considered to be less educated, while those with an upper secondary or university educations are defined as more educated.These definitions are quite similar to others in analyses for the U.S., U.K. and other countries.[5]

Instrumets

Our approach is uses the beginning-of-period population structure as an instrument for analyzing regional changes in schooling supply. The needed population data comes from the 1981 and 1991 Spanish Population Censuses provided by the National Statistics Institute.

3.2 Measurement and Descriptive Stats

Education Wage Premium

Wages depend on not only on schooling but on many other individual characteristics. To isolate the role of schooling, two approaches

[4]We follow former Spanish studies to impute these years, especially Vila and Mora (1998).

[5]Acemoglu (2002) defines this classification for the US. However, he considers this a simplification in a context in which there is a continuum of imperfectly substitutable skills.

might be used. One could use all of the available individual characteristics to build a narrow definition of worker cohorts, then calculate the education wage premium as the wage of one narrowly-defined cohort relative to another, less-educated cohort that is very similar to the first in all other dimensions. However, this strategy requires many observations. We therefore focus on a second strategy based on Mincer wage regressions (Mincer 1974). Specifically, using j for individuals, t for years, and i for regions, we estimate

$$ln(w_{it}^{j}) = \alpha_{it} + \beta_{it} S_t^j + \gamma_{it}^1 E_t^j + \gamma_{it}^2 (E_t^j)^2 + \mu_{it} X_t^j + \varepsilon_t^j. \qquad (4)$$

The left-hand side is the log of individual wages and the right-hand side contains a list of explanatory variables: years of schooling (S_t^j), years of experience (E_t^j), and other k variables (represented by the $k \times 1$ vector X_t^j) such as marital status, employment sector, gender, etc. As usual, experience is calculated as age minus years of schooling minus six. The key parameter is β_{it}, that is, the percentage increase in wages (the return) from one year of schooling in any given region/year. Once we have estimated this return,we obtain the log education premium of workers with S^H years of schooling relative to workers with S^L years of schooling in region i for year t by multiplying the difference in years of schooling by the estimated return to schooling ($\hat{\beta}_{it}$). The method used to estimate (4) is ordinary least squares.

A standard concern with Mincerian wage regressions estimated using ordinary least squares is that schooling can be correlated with unobservable characteristics (e.g., ability) that may also affect wages. While some Spanish studies have sought to address these concerns using instrumental variables, but none of them use EPF or ECPF data, since these surveys do not provide suitable instruments. Nevertheless, there two reasons to believe this concern should not affect our analysis. First, many studies have shown that the bias is quite small (Card 1999). Moreover, since our study focuses on the the evolution of the education wage premium, our analysis will not be affected by the bias as long at the latter remains approximately constant in time. Another issue is that our estimating equation implies that any individual, regardless of his or her level of education, can return for an additional year of schooling. In principle, we could relax this assumption by estimating the return to schooling only for those who have attained certain levels

Table 1: Spanish Returns to Education. 1980/81, 1990/91 and 2000/01.

	1980-81	1990-91	2000-01
β_t	0.064	0.060	0.070
	(0.001)	(0.001)	(0.003)

Note: Estimations for 1980/81 and 1990/91 are based on EPF and 2000/01 on ECPF. β_t represents the average return to education for Spain. Data in parenthesis represent standard deviations. The re- turns are estimated using Mincer equations and OLS. The sample is limited to heads of family and non self-employed workers.

of education (degrees). But we do not have sufficient data to follow this approach for some of the smaller Spanish regions.

Table 1 contains our return-to-schooling estimates (or β) for Spain as a whole, obtained using the data on individuals available in our surveys.[6] Here, it can be seen that the number of individuals returning to school fell during the 1980s and increased slightly during the 1990s, a pattern that is in keeping with the results found for other countries (for example, see (see for some examples Gottschalk and Smeeding 1997, Freeman and Katz 1995, Acemoglu 2003). There are similar, previous findings for Spain; for example, Abadíe (1997) finds that Spanish wage inequality fell during 1980s, partly due to a decrease in the return to education.[7]

Relative Supply

We first aggregate workers with only primary schooling and workers with lower-level secondary schooling using

[6] Some of the values of the estimated regional coefficients are not shown.

[7] Other works point in a different direction however, maybe because of the use of different surveys to compare trends in the return to education. Barceinas, Oliver, Raymond, and Roig (2000) estimate the return to education using EPF for 1980 and ECPF for 1985 - 1996. They found that return to education increased during this period, except between 1985 and 1991 when it fell. Their estimate of the return to education is 5.9% for 1980 and 7.0% for 1990. The estimates obtained in this paper are 6.4% for 1980, 6.0% for 1990, and 7.0% in 2000. The major differences in the 1990 figures are due to the use of ECPF data for that year.

$$L_{it} = L_{it}^1 + a_{it}^L L_{it}^2,$$

where a_{it}^L is the efficiency of workers with lower-level secondary schooling relative to workers with primary schooling. This efficiency parameter is obtained as the education premium in region i and year t of workers with no more than a secondary-school education relative workers with no more than a primary-school education. Here, the supply of more educated workers is obtained by aggregating workers with an upper-secondary education and college educated workers using

$$H_{it} = H_{it}^1 + a_{it}^H H_{it}^2,$$

where a_{it}^H is obtained obtained as the education premium in region i and year t of workers with no more than an upper-secondary education relative workers with a university degree. The log supply of education can now be obtained as

$$h_{i,t} = ln \frac{H_{it}}{L_{it}}.$$

Descriptive Statistics

Figure 2 and Table 2 contain information on the education wage premium and the relative supply of schooling for the 1980s and 1990s. It can be seen that the education wage premium fell between 1980 and 1990 (from 0.51 to 0.43) and increased between 1990 and 2000 (from 0.43 to 0.49). The implied annual growth rates are equal to -0.8% during the 1980s and 0.6% during the 1990s. The (log) relative supply of schooling, on the other hand, increased from 0.057 to 0.096 during the 1980s and from 0.096 to 0.121 during the 1990s. The implied annual growth rates were 5.2% during the 1980s and 2.3% during the 1990s.

Whether the pattern in Figure 2 and Table 2 is sensitive to the way education groups are aggregated is an important issue. As a robustness check, therefore, we classify workers with lower-secondary schooling in the higher education group and then repeat the analysis using this new classification. The results are shown in Figure 3 and Table 3.

Qualitatively, the evolution of the education wage premium and relative supply of schooling for this new classification is very similar to

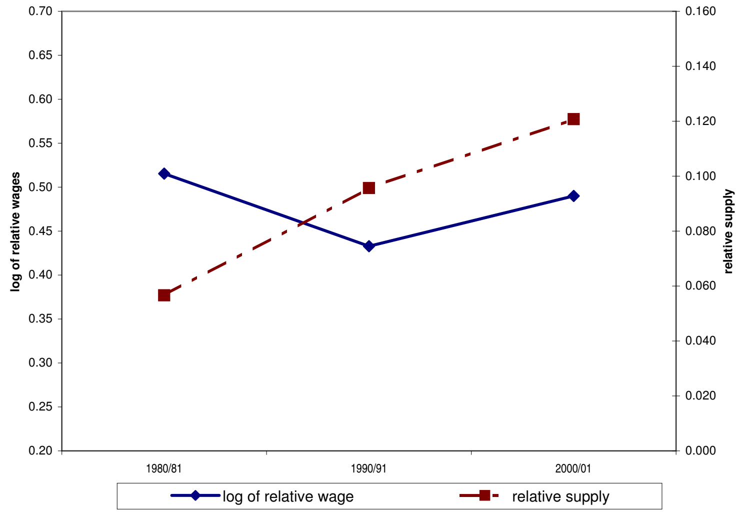

Figure 2: Education Wage Premium and Relative Supply of Skills in Spain. 1980-2000. (More educated workers have previous to college or college education)

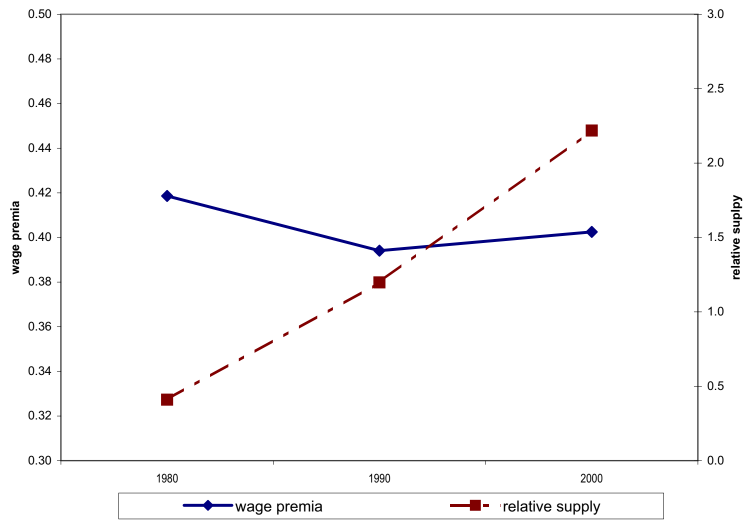

Figure 3: Education Wage Premium and Relative Supply of Skills in Spain. 1980-2000. (More educated workers have secondary or higher education)

Table 2: **Relative supply and logs relative wage in Spain.**

	1980-81	1990-91	2000-01
w_t	0.51	0.43	0.49
h_t	0.057	0.096	0.121

Note: w_t denotes the Spanish average education wage premium for year t while h_t represents relative supply for better-educated workers.

Table 3: **Relative supply and logs relative wage in Spain (II)**

	1980-81	1990-91	2000-01
w_t	0.42	0.39	0.40
h_t	0.41	1.20	2.22

Note: w_t denotes the Spanish average education wage premium for year t while h_t represents relative supply for better-educated workers.

the one we obtained earlier.

4 Estimation and Results

To gauge the extent to which the evolution of the education wage premium can be explained by the demand-supply framework, we estimate

$$\Delta\omega_{it} = \Delta b_t - \frac{1}{\sigma}\Delta h_{iSt} + (\Delta b_{it} - \Delta b_t). \tag{5}$$

where $\Delta\omega_{it}$ is the change in the education wage premium, Δb_t the national shift in education demand, $-(1/\sigma)\Delta h_{iSt}$ captures supply-driven movements along regional education demand curves, and $\Delta b_{it} - \Delta b_t$ are regional shocks to labor demand.

Changes in the regional supply of educated workers are likely to be positively correlated to shifts in regional labor demand, which implies that the inverse elasticity of substitution between more- and less-educated workers cannot be estimated by applying ordinary least squares estimation to (5). This positive correlation may be the result of worker migration to regions with rapidly rising wages, or it may reflect the fact that individuals living in regions where education is highly paid may decide to remain in school longer. Thus, it is necessary to find instruments for changes in the supply of education. Since the beginning-of-period population structure should be unaffected by shocks to regional labor demand, we will use the regional population structure in 1980 as an instrument for changes in the education supply during the 1980s and the population structure in 1990 as an instrument for changes in the education supply during the 1990s. Since changes in legal schooling requirements and better educational opportunities have increased the educational levels of younger people throughout Spain between 1980 and 2000, relative to that of the generation that retired during those same two decades, changes in the regional supply of educated workers should also correlate to changes in the supply of education. Hence, the average level of schooling should have increased more rapidly in regions where there were more young people in 1980, relative to other regions. Figure 4 shows the relationship between the population share of people between the ages of 16 and 20 at the start of the period and the variation in relative supply over the course of the following decade. Predictably, it suggests a positive link between these two variables. The beginning-of-period population share of 16-to-20-year-olds is the instrument used to estimate (5). Hence, our identifying assumption is that this population share affects the change in the education premium over the course of the following decade only through its effects on the relative supply of education.

Table 4, which presents the first stage regression, shows that the 16-to-20-year-old population share has a highly statistically significant positive effect on the growth of education supply. Interestingly, these results become even stronger once we introduce region-fixed effects to control for region-specific trends in the relative supply of education.

The first column of Table 5, which lists the second-stage results, shows the baseline specification. The remaining columns give the results of various robustness checks using other variables such as physical capital stock per worker for all sectors, physical capital per worker in in-

Table 4: First Stage Regression.

Dependent Variable	Changes in log of relative supply.			
	I		II	
16-20 years old	0.229 (0.069)	***	0.428 (0.106)	***
Constant	0.877 (0.131)	***	1.242 (0.194)	***
fixed effects	no		yes	
R^2	0.307[1]		0.601	
F-statistic	8.32		11.31	

Note: dependent variable are log changes in regional relative supply due to extra education.
The regressor (the 16-20 age group variable) represents the regional share in total population of people aged between 16 and 20.
Column I shows results exclusive of fixed effects, while column II shows results inclusive of fixed effects.
Data in parenthesis are standard errors.
*** means signicance at 1%.
(1) In I regression is adjusted R^2

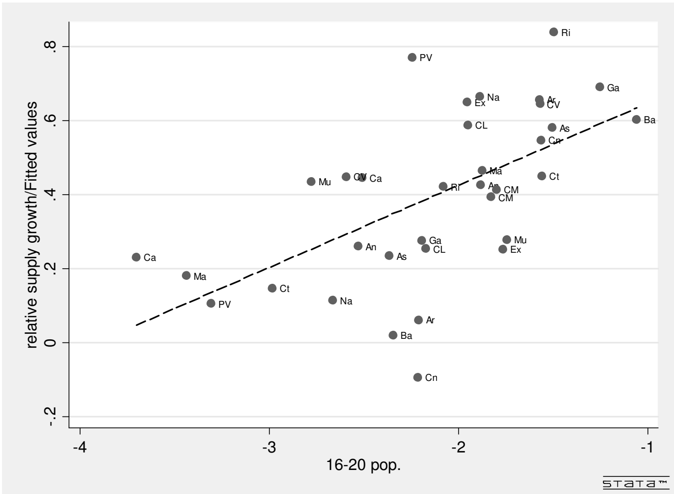

Figure 4: Relation between instruments and relative supply growth

tensive information and communication technology (ICT) sectors, and employment level.[8] Our data on physical capital per worker comes from BD-Mores, published by the Spanish Ministry of the Economy (specifically, the Department of the Economy). The ideas of these robustness checks using capital is that (some types of) capital may be complementary to educated workers and therefore affect the education wage premium. Total employment is included to test for aggregate scale effects.

The results indicate that -1/σ is between -0.58 and -0.65, meaning that the education demand curve is downward sloping. Moreover, our estimates are statistically different from zero at the 1% level. The implied elasticity of substitution between more- and less.educated workers is between 1.5 and 2. This value is very similar to that found elsewhere. Johnson (1970), for example, estimates the elasticity of substitution between more- and less-educated workers to be 1.34 for a cross-section of U.S. states in 1960. Fallon and Layard (1975) find an elasticity of

[8] ICT (Information and Communication Technology) sectors are those with a high technological content (Mas, Pérez, and Uriel 2006).

Table 5: Relative Demand Estimation

Dependent variable: log changes in regional education wage premium.

	I	II	III	IV
Δb_{80}	0,275***	0,245**	0,281***	0,024
	(0.084)	(0.114)	(0.082)	(0.291)
$\Delta b_{90} - \Delta b_{80}$	0.066	0.064	0.077	0.063
	(0.140)	(0.139)	(0.141)	(0.132)
$-\frac{1}{\sigma}$	-0,654***	-0,596**	-0,654***	-0,582***
	(0.199)	(0.251)	(0.207)	(0.176)
Δk	-	0,116	-	-
	-	(0.291)	-	-
Δk_{ict}	-	-	-0,050	-
	-	-	(0.294)	-
employ.	-	-	-	0,035
	-	-	-	(0.044)
Adj. R^2	0,48	0,49	0,48	0,49
n	34	34	34	34

Note: The dependent variable is changes in logs of regional relative wages due to extra education. $\Delta b_{80}t$ estimates changes in the(inverse) relative demand intercept in eighties. $\Delta b_{90} - \Delta b_{80}$ estimates differences in changes in the(inverse) relative demand intercept in nineties relative to eighties. $-\frac{1}{\sigma}$ estimates the coefficient associates to changes in logs of regional relative supply due to extra education or the (inverse) relative demand slope. Δk are changes in logs of regional physical capital per workers and Δk_{ict} are changes in logs of regional physical capital per workers in ICT sectors. Employment responds to log of regional employment at the start of the period. All estimations are performed controlling for regional and time effects.
*** implies significance at 1%, ** at 5% and * at 10%.
Values in parenthesis are standard deviations.

substitution between less- and more-educated workers of 1.49, using cross-country data. Angrist (1995) reports an elasticity of substitution of about 2, and Caselli and Coleman (2000) estimate the elasticity of substitution between more- and less-educated workers to be approximately 1.3. Katz and Murphy (1992), using U.S. time-series data for the 1963-1987 period, report an inelasticity of about 1.4 for substitution between more- and less-educated workers. Using different estimation methods, Ciccone and Peri (2005) argue that the long-term elasticity of substitution in the U.S. between 1950 and 1990s was between 1 and 2.

How much can education demand be seen to have increase during the 1980s and 1990s, according to our estimates? The first column shows a demand shift of 0.2715 during the 1980s, which represents an annual increase of about 2.8%. Since the difference between the pace of the education demand shifts during the 1990s relative to the 1980s is not statistically different from zero at any conventional level, we cannot reject the hypothesis that labor demand increased by the same amount during the 1990s as during the 1980s. Interestingly, our estimated increase in education demand for Spain is very similar to that estimated by Katz and Murphy (1992), who report a value of 3.3%.

Summarizing, we find that education demand grew during the 1980s at a rate roughly similar to that for 1990s, and that this increase in education demand approximates that found for the United States during the same period. Moreover, the elasticity of substitution between more- and less-educated workers found by us is also quite similar to that estimated for the United Staes.

We are now ready to decompose the change in the education wage premium into the part attributable to changes in demand and the part attributable to changes in supply. Table 6 shows this exercise. Our results show that with no shift in education demand, the education wage premium would have fallen by 2.6% per annum between 1980 and 2000. By decade, this decrease would have been much stronger during the 1980s (3.4%) than during the 1990s (1.7%). In the presence of education demand shifts only, the education wage premium would have increased by 2.8% during both the 1980s and the 1990s. The last column shows that the change in the education wage premium predicted by the demand-supply model comes close to the change actually

Table 6: Decomposition of Relative Wage Changes.

	wages	supply	demand	error
1980/81 – 1990/91	-0,7	-3,4	2,8	0,0
1990/91 – 2000/01	1,4	-1,7	2,8	0,4
Average	0,4	-2,6	2,8	0,2

Note: *Supply* represents relative wage growth rates if the only change is in relative supply, or changes in relative wages along the relative demand curve. Wages are the values for relative wages derived from section 3.2. *Demand* represents the growth rates given by the common constant in (5).

observed in the premium.

5 Labor Institutions

Let us now examine whether our conclusions above are robust to the influence of wage-setting institutions. These institutions have changed in almost all countries during recent decades. In Spain, a new system of labor regulation was introduced during the 1980s [9], the most important feature of which was centralized collective bargaining (CB).[10] The latter involved wages being negotiated between unions and employer associations, as it did in other European Countries such as Germany.[11] CB agreements set a wage floor, and while only 18% of workers are paid at the negotiated rate, they tend to be the least-paid of all workers; see (Dolado, Felgueroso, and Jimeno 1997) (hereafter DFJ).[12] Hence, education premia could in principle be affected by CB wage floors; more importantly from our perspective, the evolution of the education

[9] Ley del Estatuto de los Trabajadores (1980).

[10] Almost 50% of negotiations take place at sector-province level; 26.6% are at sectoral negotiations at the national level.

[11] Despite very low union affiliation, almost 80% of workers are covered by some collective bargaining agreement as negotiations are binding for most non-union workers.

[12] Dolado, Felgueroso, and Jimeno (1997) also explain that the real value of the minimum wage does not play any role in wage determination. They show that the lowest wages are determined by the CB wage floors, and that there is no link between the minimum wage and CB wage floors.

Table 7: : Growth in Unemployment Rate by Education Groups in Spain.

	1980-85	1985-90	1990-95	1995-00
none or primary only	77.3	-20.1	51.6	-34.2
lower-secondary	63.3	-35.4	28.8	-45.5
upper-secondary	56.4	-27.5	47.2	-34.0
tertiary	75.4	-27.4	31.1	-43.7

Note: data from Human Capital Series compiled by IVIE. Spain

wage premium in Spain may have been affected by increasing the CB wage floors leading to wage compression (while there is a minimum wage in Spain, this wage falls below the wage floor set by CB and is therefore not regarded as binding). One way to check whether trends in CB wage floors did indeed raise the wages of least-educated workers, relative to the market-clearing wage level, is to examine whether the unemployment rate among less-educated workers increased more rapidly than it did among other education-classified worker groups. Table 7, which lists the percentage change in unemployment rates by worker education category, shows no marked differences between less-versus more-educated workers as far as unemployment trends are concerned. For example, between 1980 and 1985 (a time of rising overall unemployment), the rates for workers with higher versus lower levels of education exhibited similar trends. Between 1995 and 2000, a period characterized by falling unemployment, both the primary and upper-secondary education groups registered the same decline. In summary, over the course of the past twenty years a similar trend has characterized unemployment among workers in all education categories.

Another way to check whether our conclusions are driven by CB is to re-estimate our demand-supply model after excluding workers for whom the floors of CB agreements are likely to be binding. DFJ argue that bargained wages earned by the most CB-influenced workers fell below 125% of the minimum wage in the early 1980s and below 140% of the minimum wage in 1990. Because their study ends in 1996, we have to approximate their criterion for the year 2000. Our basic assumption is that the most CB-influenced workers earned less than the average wage reported for a Spanish "peones" (unskilled workers) in 2002 Wage Structure Survey, if we take into account CPI inflation between 2000 and 2002. Table 8 shows the results of our re-estimated model, after eliminating workers whose wages fell below the specified cutoffs. Here, the slope and the intercept are almost identical to those obtained earlier. Our conclusions regarding the evolution of the Spanish education wage premium therefore continue to hold.

6 Conclusions

The main aim of this paper was to examine the extent to which a demand-supply model may be used to explain the evolution of the education wage premium during the 1980s and the 1990s. Our key finding was that the evolution of relative supply represented the main driving force behind the changes in this premium, since the demand for education rose at a similar pace during the two decades under study. We also found that the increase in the demand for education during our study period–about 2.8% per year–roughly approximated that estimated for other countries, including the United States. Another important finding was that the elasticity of substitution between more- and less-educated workers in Spain was about 1.5, and thus almost identical to that obtained in previous cross-country and cross-regional studies. Our study therefore suggests that the trend in the Spanish wage premium can be explained quite well by market forces.

References

Abadíe, A. (1997): "Changes in Spanish Labor Income Structure During the 1980's: A Quantile Regression Approach," *Investigaciones Económicas*, XXI(2), 253–272.

Abraham, K. G., and S. N. Houseman (1993): "Earnings Inequality in Germany," Staff Working Papers 94-24, W.E. Upjohn Institute for Employment Research.

Acemoglu, D. (2002): "Technical Change, Inequality, and the Labor Market," *Journal of Economic Literature*, 40(1), 7–72.

Table 8: Relative Demand Estimation exclusive of institutional effects

	I	II	III	IV
Δb_{80}	0.267*** (0.085)	0.237** (0.115)	0.271*** (0.083)	-2.800 (4.180)
$\Delta b_{90} - \Delta b_{80}$	0.063 (0.141)	0.063 (0.140)	0.074 (0.143)	0.064 (0.131)
$-\frac{1}{\sigma}$	-0.632*** (0.200)	-0.574** (0.252)	-0.631*** (0.208)	-0.535*** (0.198)
Δk	- -	0,112 (0.252)	- -	- -
Δk_{ict}	- -	- -	-0,038 (0.208)	- -
employ.	- -	- -	- -	0,488 (0.198)
Adj. R^2	0,47	0,49	0,49	0,49
n	34	34	34	34

Note: The dependent variable is changes in logs of changes in logs of regional relative wages to due extra education. $\Delta b_{80}t$ estimates changes in the(inverse) relative demand intercept in eighties. $\Delta b_{90} - \Delta b_{80}$ estimates differences in changes in the(inverse) relative demand intercept in nineties relative to eighties. $-\frac{1}{\sigma}$ estimates the coefficient associates to changes in logs of regional relative supply due to extra education or the (inverse) relative demand slope. Δk are changes in logs of regional physical capital per worker and Δk_{ict} are changes in logs of regional physical capital per worker in ICT sectors. Employment represents the log of regional employment at the start of the period. All estimations are performed controlling for regional and time effects. Institutional effects are assumed to be removed by deleting workers with wages below 25%, 40% and 60% of the minimum wage for 1980/81, 1990/81 and 2000/01. Institutions are assume to be eliminated deleting those workers with wages lower than 25%, 40% and 60% of minimum wage for 1980/81, 1990/81 and 2000/01.
*** implies significance at 1%, ** at 5% and * at 10%.
Values in parenthesis are standard deviations.

——— (2003): “Cross-Country Inequality Trends,” *Economic Journal*, 113(485), 121–149.

Angrist, J. (1995): “The Economic Returns to Schooling in the West Bank and Gaza Strip,” *American Economic Review*, (85), 1065–1087.

Arellano, M., S. Bentolila, and O. Bover (2001): “The Distribution of Earnings in Spain During the 1980s: The Effects of Skill, Unemployment and Union Power,” CEPR Discussion Papers 2770, C.E.P.R. Discussion Papers.

Barceinas, F., J. Oliver, J. Raymond, and J. Roig (2000): “Los Rendimientos de la Educación en España,” *Papeles de Economía Española*, (86).

Card, D. (1999): “The causal effect of education on earnings,” in *Handbook of Labor Economics*, ed. by O. Ashenfelter, and D. Card.

Card, D., F. Kramarz, and T. Lemieux (1999): “Changes in The Relative Strustures of Wages and Employment: A Comparision of the United States, Canada and France,” *The Canadian Journal of Economics*, 32(4), 843–877.

Caselli, F., and W. Coleman (2000): “The World Technology Frontier,” *NBER working papers*, 7094.

Ciccone, A., and G. Peri (2005): “Long-Run Substitutability Between More and Less Educated Workers: Evidence from U.S. States, 1950-1990,” *The Review of Economics and Statistics*, 87(4), 652–663.

Dolado, J., F. Felgueroso, and J. Jimeno (1997): “The Effects of Minimum Bargained Wages on Earnings: Evidence from Spain,” *European Economic Review*, 41, 713–721.

Fallon, P., and P. Layard (1975): “Capital-Skill Complementarity, Income Distribution and Output Accounting,” *Journal of Political Economy*, 83, 279–302.

Freeman, R., and L. F. Katz (1995): *Differences and Changes in Wage Structures*chap. Introduction and Summary. University of Chicago Press, Chicago, freeman, richard and lawernce f. katz edn.

Gottschalk, P., and M. Joyce (1998): “Cross-National Differences In The Rise In Earnings Inequality: Market And Institutional Factors,” *The Review of Economics and Statistics*, 80(4), 489–502.

Gottschalk, P., and T. M. Smeeding (1997): "Cross-National Comparasions of Earnings and Income Inequality," *Journal of Economic Literature*, 35, 633–687.

Hamermesh, D. (1993): *Labor Demand*. Princetown University Press.

Johnson, G. E. (1970): "The Demand for Labor by Educational Category," *Southern Economic Journal*, (37), 190–203.

Katz, L., G. Loveman, and D. Blanchflower (1995): *Differences and Changes in Wage Structures*chap. A Comparison of Changes in the Structure of Wages in Four OECD Countries. University of Chicago Press, Chicago, freeman, richard and lawernce f. katz edn.

Katz, L. F., and K. M. Murphy (1992): "Changes in Relative Wages, 1963-1987: Supply and Demand Factors," *The Quarterly Journal of Economics*, 107(1), 35–78.

Martinez-Ros, E. (2001): "Wages and Innovations in Spanish Manufacturing Firms," *Applied Economics*, 33(1), 81–89.

Mas, M., F. Pérez, and E. Uriel (2006): *El stock y los servicios del capital en españa y su distribución territorial (1964-2003)*. Fundación BBVA.

Mas, M., F. Pérez, E. Uriel, L. Serrano, and A. Soler (2002): "Metodología para la Estimación de las Series de Capital Humano. 1964-2001," .

Mincer, J. (1974): "Scholling, Experience and Earnings," Discussion paper, National Bureau of Research, New York.

Torres, V. X. T. (2002): "Dispersión salarial y cambio tecnológico en la industria española," *Investigaciones Economicas*, 26(3), 551–571.

Vila, L., and J. Mora (1998): "Changing Returns to Education in Spain During the 1980s," *Economics of Education Review*, 17(2), 173–178.